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INFORMATION MANAGEMENT FOR THE TACTICAL OPERATIONS SYSTEM (TOS)

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Vector Research, Inc., and Perceptronics, Inc.

HUMAN FACTORS TECHNICAL AREA

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This executive summary presents synopses of three items resulting from the first phase of a project to establish guidelines for a Standing Operating Procedure (SOP) for managing information at the division level within the Tactical Operations System (TOS), an automated staff-operations information system. Two research products were developed, a provisional SOP and a TOS design/decision aid model. ARI Technical Report 385, the third item, presents the qualities found to be characteristic of a "good" summary of battlefield intelligence information.

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INFORMATION MANAGEMENT FOR THE TACTICAL OPERATIONS SYSTEM (TOS)

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TOS Information Management

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FOREWORD

The Human Factors Technical Area is concerned with the demands of the future battlefield for increased man-machine complexity to acquire, transmit, process, disseminate, and utilize information. The research is focused on interface problems and interactions within command and control centers and is concerned with such areas as topographic products and procedures, tactical symbology, user oriented systems, information management, staff operations and procedures, and sensor systems integration and utilization.

One area of special interest is managing the flow of information on the battlefield. Research results are used in defining preferred staff operations and procedures to enable users to derive maximal benefit from automated information systems. The present publication provides a summary of the first phase of research to develop guidelines for a Standing Operating Procedure (SOP) for information management within the Tactical Operations System (TOS). Specific aspects of the first phase research are described in more detail in the following reports:

a. Guidelines for Information Management in the Tactical Operations System (TOS): Provisional Standing Operating Procedures (SOP) (ARI Working Paper HF79-1).

b. A Design/Decision Aid for the Tactical Operations System (TOS) (ARI Working Paper HF79-2).

c. Information Summarization in a Corps Level Scenario (ARI Technical Report 385).

Research in the area of information management is conducted as an in-house effort augmented through contracts with organizations selected for their unique capabilities and facilities for this research. The present study was conducted by a government-contractor team with personnel from Vector Research, Inc., and Perceptronics, Inc., under contract DAHC 19-78-C-0027 with program direction from Dr. Edgar M. Johnson. Government personnel who made substantial contributions include Dr. Stanley Halpin and Mr. Rex Michel of ARI, numerous individuals from the TOS Manager's Office in the Combined Arms Combat Developments Activity (CACDA) at Fort Leavenworth, Kans., and personnel from the 3rd Armored Division, Fort Hood, Tex. The Vector Research Inc. team was comprised of Dr. Robert W. Blum (Project Leader), Mr. William D. Kinley (Assistant Project Leader), Ms. Cathleen A. Callahan, Mr. Mark G. Graulich, and Mr. Gray Witus. The Perceptronics team consisted of Mr. Michael G. Samet and Dr. Ralph E. Geiselman.

This effort is responsive to requirements of Army Project 2Q263743A774, and to special requirements of the Combined Arms Combat Development Activity, Fort Leavenworth, Kans. Special requirements are contained in Human Resource Need 79-109 (Information Management with the Tactical Operations System--TOS).

Joseph Zeidner

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Technical Director

CONTENTS

1.0 INTRODUCTION AND BACKGROUND

The Tactical Operations System (TOS) is a battlefield computer system for processing and storing information to be used by the Division commander and his staff in support of tactical decision making. The large volumes of information anticipated to be available to TOS through use of modern data collection technology pose the potential of hardware and software overloads for a system which must be constrained in size due to considerations such as the needs for mobility and low vulnerability. Coupling this potential problem with the possibility of overloading the human users of the system with an inordinate amount of information which they are unable to assimilate led to the requirement for developing procedures for managing the use of TOS and its data base.

The project was initiated under the assumption that a particular set of standard operating procedures for information management in TOS would be developed which, at the end of an anticipated three-year effort, could be adopted with little change by any division employing TOS. During the course of the first fourteen-month phase of the contract, that concept has evolved into a more general, flexible, and hopefully even more useful one. The present intention is to produce "guidelines" for SOP development, the guidelines to be used by the individual divisions to structure TOS information management concepts to meet their own needs, and to incorporate them into their respective division field SOP.

For this reason, the primary product of this project (summarized in section 2.1 of this report) has been titled Guidelines for Information

Management in the Tactical Operations System (TOS): Provisional Standing Operating Procedures (SOP) (ARI Working Paper HF79-1). That document will be further revised in subsequent phases of the project to reflect the ongoing development of TOS and to incorporate results of experiments, first with the TOS design/decision aid (introduced next), then with TOS itself when it is available for testing. The final SOP guidelines document will be in manual format and is intended to be used in conjunction with the TOS users' manual (oriented to the specific details of how to operate TOS, enter messages, etc.) and the "How to Fight with TOS" manual (oriented to how best to use the information and capabilities available with TOS in making decisions, preparing plans, etc.). It should be re-emphasized that the SOP Guidelines manual is intended to be used for the management of TOS and its data base.

The design/decision aid (DDA) for TOS, which is summarized in section 2.2 of this volume, has assumed a greater importance to the project than was originally proposed. It was originally thought that a very simplified model (the DDA) of the effects of data loading and handling in TOS could be developed in the first phase of the project in order to minimize the amount of direct experimentation with TOS necessary to evaluate the effects of various management policies. In the proposal, it was assumed that a working version of TOS would be available for the core experimental work relatively early in the project, at minimum, by the beginning of the second phase. However, as events progressed, it became evident that an operational TOS may not be ready until the third phase of the project. For that reason, the TOS DDA has been developed with a great degree of sophistication and flexibility to represent TOS

as it goes through its final stages of development. The DAA will be the primary vehicle for developing and testing the management policies and their parameters that will be contained in the final SOP guidelines.

Finally, section 2.3 contains a summary of the basic experimental research on information summarization conducted during this project phase. The original intent of concurrently carrying out research to fill in gaps uncovered during the course of the SOP developmental work is exemplified here. It became clear during the early part of the first phase that there is a lack of knowledge on how best to summarize information sets. Specifically, the issue was how one should summarize the data base or some portion of it for use during system "down times". This led to issues such as how humans summarize information in general, what constitutes a "good" summary, etc. The results of the research inquiry which was undertaken will be incorporated in the refinement and elaboration of the SOP guidelines in the next phase.

2.0 SUMMARIES OF PRODUCTS AND RESULTS

This chapter presents summaries of the three reports produced during the first phase of this project. The first, in section 2.1, explicitly addresses the overall objective of the project -- to produce a self-contained document of SOP guidelines. The second and third, in sections 2.2 and 2.3, present the results of efforts expended in support of developing the SOP guidelines: section 2.2 describes a model of TOS which will be used in future phases to evaluate the effect of management policies of TOS, and section 2.3 presents the results of a research effort that investigated certain aspects of information summarization which are pertinent to policies related to message summarization for TOS.

2.1 SUMMARY OF GUIDELINES FOR INFORMATION MANAGEMENT IN THE TACTICAL OPERATIONS SYSTEM (TOS): PROVISIONAL STANDING OPERATING PROCEDURES (SOP):

2.1.1 INTRODUCTION

Information management procedures are required for TOS to maximize the availability of information from the system and to prevent or circumvent the identified problems of system overload, storage overload, and user overload. The methods suggested for preventing these overloaded states involve both monitoring and controlling the system and the system users.

The report does not contain an SOP, but provides both the guidelines necessary for developing SOP for information management and recommendations and rationale for specific SOP. It is written primarily for a task force assigned to write a TOS SOP for its division, and provides direct input to such an SOP as well as discussion of other management procedures which would supplement or be supplemented by the development of operational procedures for other TOS functions. Again, to clarify, the report assumes the reader and user is familiar with TOS and its role in division operations and, therefore, contains only that input which pertains to information management in TOS.

2.1.2 OVERVIEW OF SOP GUIDELINES

The topics addressed in the report have been identified as ones which, if unmanaged, may contribute to inefficient utilization of the TOS system. These topics have been organized into six general areas for purposes of developing guidelines for information management: (1) an overall framework for management of TOS, (2) user guidelines, (3) system management guidelines, (4) methods for monitoring and controlling TOS, (5) file management guidelines, and (6) a guideline for operation with a degraded system. The discussion given for each topic of concern covers the reasons for developing management procedures, suggestions for management procedures and their implications, and, where possible, example procedures.

The TOS system is managed by the system controller (SYSCON) and the file managers. The SYSCON acts as the overall manager

of information processing in TOS and resolves the conflicts between the technical capabilities of TOS and the operational needs of the users. A file manager's responsibility is to ensure that the contents of the files delegated to him provide the maximum information value to the file users. The SYSCON and file managers work together to maintain both satisfactory operation of the system and the utility of the information stored in the system. The framework adopted in the manual, upon which the management of the TOS system is based, is based on the concept of a set of operating levels. This framework facilitates coordination of procedures and communication among the SYSCON, the file managers, and the TOS operators. Briefly, each user is provided a set of four operating levels, each of which is a set of constraints on his utilization of the system. The constraints include such things as rates at which he may update and query the data base. The constraints defining the levels range from relaxed to restrictive, and the level at which an individual user is instructed to operate the system is dependent on that user's need to access the system, the system status, and the battlefield situation.

The SYSCON will appropriately change the operating level of users in response to changes in system status, the user's need, and the battlefield situation. An additional management tool, developed for use by the SYSCON to minimize the task of changing individual user operating levels, is to group users which are alike in terms of their utilization of the system and to control their operating levels by groups. For example, users with similar demands on TOS may be treated by the SYSCON as one group of users, and changes made to the operating level of the group apply to all members of the

group. In addition, changes in group membership may occur during the course of a battle. This grouping is for the convenience and efficiency of the SYSCON, and individual users could be unaware of their grouping.

A second area for which SOP guidelines have been developed concerns the preparation of messages, primarily the definition of values for the message fields which have no prescribed contents. The definitions given for such fields should be easily understood and consistent with other fields requiring such definitions and with those fields which have similar context and whose field values are prescribed.

The third category of information management guidelines concerns the use of the TOS information processing function. Control of the utilization of queries and updates to the data base is maintained with the use of operating levels. The other functions, specifically standing requests for information (SRI), correlations, thresholds, and filters, are managed by allotting to each user a specific number of such requests which he may have present in the system at any time. Another concern involving management of the processing function includes a tradeoff between the use of SRI and distribution lists (D/L) to obtain information. D/L are useful for distributing those messages which satisfy relatively permanent and known information needs while SRI provide the means to obtain those pieces of information for which an immediate knowledge is necessary. SRI may act as a substitute method for obtaining information which may be otherwise received via a D/L, but the additional processing time required by SRI may be detrimental to the operation of TOS if such reliance is placed on SRI. Clearly, a tradeoff exists between these two methods of distributing information.

The fourth area for information management concerns methods for monitoring and controlling the TOS system. Methods for monitoring the system include measurement of the TOS performance and the demands made by the users on the system. Methods for controlling the system include the use of operating levels, mentioned previously, filtering, hierarchical review, and purging. The proposed methods for purging data from the data base include automatic purging of records which relatively quickly become obsolete; a routine purge which requires periodic review of certain types of messages to be checked for possible deletion due to obsolescence; or changes in the battlefield situation; and finally, "as required" purges which may be necessary due to an increase in the demand for file space, a degradation of the system status, etc. All these types of purging are integrated as a means of managing the content and especially the size of the data base.

The fifth category of information management procedures addresses the unique problems of each file. These problems include an anticipated high rate of interaction with the enemy situation data (ESD) file, interactions between all files, and the establishment of both temporary and permanent division-unique files through the use of the staff working file (SWF) option.

The final area for which SOP guidelines for information management have been developed concerns the processing of information during degraded modes of operation. Degraded modes include the loss of the use of certain information-processing functions or a TOS physical device due to hardware or software problems or combat damage. The shutdown of the Division Computing Center (DCC) due to maintenance or displacement

is systematically achieved by a gradual curtailment of users' interactions with the system, reducing the operating levels, and prioritizing the final information processing requirements. Likewise, successful restart of the system is planned by a gradual increase in the demands placed on the system. The guidance given for preparation for unplanned degradation to the DCC includes summarization of various types of information which are necessary for continued operation without TOS.

2.1.3 TAILORING THE SOP

The capability for individuals to tailor an SOP to meet their specific needs has been a primary consideration during the development of the SOP guidelines for information management. Each division and units within the division are likely to have unique characteristics and operating preferences. Therefore, alternative guidleines and variations in management procedures are discussed under each topic presented in this report where such tailoring capability is pertinent. It is envisioned that the task force assigned to develop an explicit TOS SOP to augment the unit's field SOP will use as a starting point the SOP guidelines for information management and the examples of specific SOP presented in the report to develop an SOP which meets its unique needs.

2.2 A DESIGN/DECISION AID FOR THE TACTICAL OPERATIONS SYSTEM (TOS)

2.2.1 INTRODUCTION

A design/decision aid (DDA) was developed to aid in the design and evaluation of information management procedures for TOS. The DDA is a mathematical model of the Division Computer Center (DCC).[1] The role of the DDA is to estimate the impact of management procedures on the reliability,[2] responsiveness,[3] and components of congestion[4] of the DCC under specified user demand loads.

Provided below is an overview of: (1) the background of the DDA, (2) the description of the DDA, and (3) the anticipated future directions of work with the DDA. This subject matter is presented in detail in the full report.

2.2.2 BACKGROUND

In the fall of 1978, a preliminary version of a DDA was developed with a fixed representation of the DCC hardware and software configuration, and a fixed set of values of the parameters describing the processing

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[1]The scope of work of the currently contracted effort did not extend beyond the DCC to its peripherals or to the supporting communications nets.

[2]The system reliability can be thought of as having two components: (1) the probability that no memory buffer will become saturated in the next time period, and (2) the expected time until the saturation of a memory buffer.

[3]Responsiveness has two components: (1) the timeliness of the information in the data base, and (2) the speed with which information is processed. The timeliness of the data base is not an issue addressed by the DDA. Therefore, throughout the remainder of this discussion, responsiveness shall refer to the speed with which information is processed.

[4]The components of congestion of the DCC include such factors as the loads on the main-frame and front-end processors, and the disk access requirements.

rates.[1] This version of the DDA was programmed on a hand-held calculator. Although this preliminary version demonstrated significant potential for aiding in information management procedure development, a major shortcoming was felt to be inaccuracies in the representation of the DCC as a consequence of the fixed values incorporated into the preliminary model.[2] This shortcoming has been eliminated. The DDA described in this paper is a general model, and is almost entirely input-driven, i.e., the level of detail and the DCC configuration are specified by the inputs. As more definite information regarding the DCC operation becomes available, the congestion-prone areas of the DCC can be identified, and an appropriate level of detail for the DDA can be selected. The generality and complexity of the DDA could then be greatly reduced. It is anticipated that the final form of the DDA could be programmed on a hand-held calculator, implemented via table-and-chart procedures, or even programmed directly into the TOS system.

2.2.3 DESCRIPTION OF DDA MODEL

The DDA is a general mathematical model of the DCC. That the DDA is a general model means that it can be adapted to reflect changes in the DCC hardware or software without changing the DDA, merely by adjusting the values of some of the input parameters. Therefore, it is likely the DDA

[1] Documented in the working paper, A Design/Decision Aid for the Tactical Operations System (TOS) Division Computing Center (DCC), 10 November 1978, DRAFT.

[2] At the time that the DDA was developed, software documentation for the DCC was not available, and only the A-level specifications had been released. Consequently, hard data describing the DCC could not be obtained.

will not have to be modified to any significant degree to reflect developments of the DCC. Furthermore, the same DDA can be used to model a degraded DCC (e.g., with one malfunctioning disk unit) by adjusting the input parameter values.

The DDA is an analytic model consisting of a set of mathematical equations. The equations were obtained by representing the DCC computer network as a queuing network and adapting standard queuing theory results to this application. An analytic model,[1] the DDA uses expected (average) values; for example, average arrival rates.

Provided below is a discussion of: (1) the inputs to the DDA; (2) the outputs available from the DDA; (3) the queuing network representation of the DDA; and (4) the analyst's activities supporting the use of the DDA. More detailed discussions are presented in subsequent chapters.

2.2.3.1 Inputs to DDA

The DDA requires three basic types of inputs: (1) configuration inputs; (2) usage inputs; and (3) processing inputs. The configuration inputs describe the basic structure of the DCC; e.g., the number of processors. The usage inputs, e.g., the job arrival rates, describe the external demands on the DCC. The processing inputs describe the dynamics of DCC operation, e.g., how jobs are routed among the processors.

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[1]With an analytic model, a specific set of input values will always produce the same output values. The DAA differs in this way from a discrete event ("Monte Carlo") simulation in which a particular set of inputs can produce a different set of outputs on each run.

2.2.3.2 Outputs from DDA

The DDA produces three types of outputs: (1) reliability outputs; (2) responsiveness outputs; and (3) intermediate outputs. The reliability outputs have two components: (1) the probability that a memory buffer will become saturated within a given time interval; and (2) the expected time until the saturation of a memory buffer. The responsiveness outputs have one component for each type of job represented in the inputs: the mean time elapsed between initiation and completion of DCC processing on each type of job.

The intermediate outputs are computed during the process of computing the reliability and responsiveness outputs. There are six intermediate outputs produced by the DDA describing the internal status of the DCC, e.g., the utilization[1] of each of the processors.

Reliability and responsiveness are two of the three primary measures of DCC performance (accessibility being the third) and will be used in future phases of the project to evaluate candidate management procedures. The intermediate outputs will be used to analyze the interactions of various inputs and how changes in the inputs affect the outputs. The intermediate outputs are, therefore, expected to be useful in guiding the selection of candidate management procedures.

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[1]The utilization of a processor is the ratio of the arrival rate of tasks to the service rate of the tasks. A utilization greater than one means that tasks are arriving faster than they can be processed.

2.2.3.3 Queuing Network Representation of the DCC

The DDA is concerned with representing the flow and processing of information in the DCC. The DDA does not represent and is not concerned with the content of the information handled by the DCC. The DDA relates the DCC processing capacity and the user demands on that capacity (accessibility) to congestion in the DCC, and relates that congestion to the performance measures defined as reliability and responsiveness.

A queuing network is a particular type of mathematical structure well suited to representing congestion in computer networks such as the DCC.[1] The queuing network representation is based on a description of how the system operates, and is concerned with such factors as how busy the processors are, how the processors are interconnected to form subsystems, how the memory buffers are used by the subsystems, and how processing is routed through the network.

2.2.4 APPLICATION ACTIVITIES

It is anticipated that three tasks will be performed in order to set the stage for analysis of management procedures: (1) collection of input data; (2) selection of candidate management procedures and estimating their impacts on user demands for DCC accessibility; and (3) selecting a set of scenarios describing potential TOS field environments and

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[1] See B. Beizer, Micro-Analysis of Computer System Performance, New York: Van Nostrand Reinhold, 1978, and L. Kleinrock, Queuing Systems, Volume 2: Computer Applications, New York: John Wiley and Sons, 1976.

estimating the user demands for accessibility in these environments. These activities will provide the background for the design and evaluation of information management procedures.

2.2.5 FUTURE DIRECTIONS

It is anticipated that future work on the DDA will occur in five areas: (1) extensions to include the supporting communications net; (2) implementation; (3) collection of input data; (4) experimentation; and (5) validation. The near-term implementation effort is expected to include developing a computer program to execute the DDA equations.

The collection of input data could include activities such as consulting with the software developers, analyzing the software documentation, and extrapolating from the B-level specifications. These could result in specifying a level of detail for the DDA and fixing values for some of the inputs. These results could make possible simplifications of the computer program implementation which could, therefore, reduce the computer requirements.

Experimentation would involve the use of the DDA to estimate the impacts on the DCC of various candidate management procedures under various field situations. A by-product of this analysis would be an identification of those areas of the DCC which contribute little to the overall congestion effects. The representation of these aspects of the DCC might be eliminated from the DDA, resulting in further reductions in the computational requirements.

Validation refers to determining whether or not the DDA outputs are similar to those that would have been obtained from experimentation with a working prototype DCC. Validation can be accomplished by comparing the predictions of the DDA to the performance of a prototype DCC, and then determining whether or not any disparities would have made any difference in the design or selection of the management procedures. If no significant disparities are detected, the DDA can be accepted as a valid model of the DCC, at least in prototype. In the interim until a prototype DCC can be realized, the utility of the DDA for investigating user requirements, design trade-offs, and operational test designs should not be underestimated.

2.3 SUMMARY OF INFORMATION SUMMARIZATION IN A CORPS LEVEL SCENARIO

2.3.1 INTRODUCTION

Summarization involves the condensation or reorganization of information. Within the Army's Tactical Operations System (TOS), information summarization can be expected to fulfill multiple purposes. For example, summarization procedures can be employed to enhance the efficiency of data utilization when the system is operating well, to prevent overloads on the TOS hardware and software, and to provide hard copy backup information if the computer-based system should go down. These kinds of information reduction functions have a very simple rationale behind them; namely, to reduce user cognitive load, to reduce system load, or both. Whatever the motivation, however, alternative approaches to summarizing information are possible and their potential effectiveness requires thoughtful analysis.

Although the effects of information overload on decision performance are not fully understood, there is a general concensus that if too much information is presented, meaningful data interpretation and effective decision making are retarded. The potential problem of information overload is especially evident in TOS, where the technical capability of the system will most likely increase the density of intelligence information to the point where it will overwhelm the users. Therefore, appropriate summarization procedures must be developed within the framework of automated systems to condense and to organize the volume of information into a form that can be used efficiently and effectively.

To obtain data to support the development of useful guidelines for summarization of TOS message content, particularly tactical intelligence data, an initial experimental investigation was designed and conducted. The approach taken was "product-oriented" rather than "process-oriented." That is, the focus of the study was not on <u>how</u> summaries of intelligence data are generated; instead, an attempt was made to first identify "good" summaries and then to analyze their properties and structural characteristics. In this manner, the essence of <u>what</u> makes an effective summary could be used to suggest guidelines for summarizing one type of tactical data.

A reasonable alternative to the present experiment would have been to study field manuals, inspect current course outlines, and ask selected "experts" for their opinion about what a "good" summary should contain. However, such an approach only yields a definition of what should be. Given the advantage of adequate time, we preferred to take a more basic look at what is actually done by a selected sample of officers. At worst, we will verify the status quo; at best, we will uncover tendencies that

provide valuable clues for future research which will develop new procedures to reconcile differences between doctrinal requirements and observed performance.

2.3.2 METHOD

In brief, 19 staff officers were asked to read a description of a defensive tactical scenario and examine 30 enemy situation data (ESD) messages. The messages, presented in current TOS format, were selected from the Corps TOS scenario and described the beginning of a border crossing and attack in Germany by Warsaw Pact forces. The participants' task was to rate each message in terms of how essential it is to the understanding of the situation at hand, and to summarize the tactical information contained in the messages in preparation for a three minute briefing of the G2. The summaries from three participants were eliminated from the data set because it was strongly suspected that their performance was based upon previous familiarity with the scenario from which the present materials were drawn, rather than upon the subset of materials actually used (e.g., map coordinates and events were mentioned that did not appear in the subset of information given to the participants). The remaining 16 hand-written summaries were then typed and rated by five experienced military officers with relevant experience ("evaluators") in terms of content, accuracy, and organization. For each summary, an overall numerical evaluation, as well as specific critical comments concerning positive and negative qualities were also collected.

Following the work of Kintsch and van Dijk[1], it was assumed that a summary is representative of the summarizer's basis for evaluation and

[1] W. Kintsch and T.A. van Dijk, "Comments on Summaries of Stories," Languages, 1975, 40: 98-116.

mental organization of the message content. This basis, which is an organized knowledge structure, or schema, provides a mental outline for the learner onto which the appropriate elements from the material to be learned can be "attached." Consequently, a major analytical task toward the development of guidelines for summarization was to extract the schema that was applied successfully to the messages by the staff officers in generating "good" summaries.

Operationally, a schema can be defined as a two-dimensional, or hierarchical outline with the dimensions being subordination and sequential order. Subordination has typically been determined using derivational rules applied directly to the full text, but this procedure is time-consuming and is often highly subjective. Fortunately, the subordination of information based upon derivational rules has been found to be correlated with the likelihood that a reader will include the information in a summary of the full text (Thorndyke[1]). Therefore, in the present experiment, subordination could be determined for each message in terms of the percentage of the staff officers that included some aspect of that message in their summaries. A message with a higher inclusion percentage was assigned a higher position in the structure.

Sequential order was assessed by deriving an output-position percentile for each message included in each staff officer's summary, which allowed for the median output-position percentile for each message to be computed across summarizers. Following Bjork and Whitten[2], the output-position percentile [(sequential position of a message in a summary/total

[1] P.W. Thorndyke, "Cognitive Structures in Comprehension and Memory of Narrative Discourse", Cognitive Psychology, 1977, 9: 77-110.

[2] R.A. Bjork and W.B. Whitten, "Recency-Sensitive Processes in Long-Term Free Recall," Cognitive Psychology, 1974, 6: 173-189.

number of messages included in the summary) X 100] is a measure of output position where the derived value is standardized with respect to the number of elements in the output. Once the two-dimensional underlying structure was characterized in terms of the messages, the discriminable components of the structure (message clusters) were labeled, in terms of their general content, as nodes in the schema.

Since a major portion of some summaries could be based upon inferences drawn from the messages (Thorndyke),[1] or upon different aspects of the same messages, the analysis based upon direct references to the 30 messages was seen as informative, but not sufficient for the development of guidelines for summarization. To allow for the inclusion of an interpretation of the intelligence information in the schema, a separate analysis was conducted based upon the content of the summaries irrespective of the content of the messages. First, a list of general topics included in the "good" summaries, as defined by the evaluators' overall evaluations, was generated. These topics were systematically extracted from the summaries themselves, and therefore they were not necessarily mutually exclusive. However, they were exhaustive with respect to the content of the summaries sampled. Then, a median output-position percentile was computed for each topic that was included in the "good" summaries. The subordination dimension was scaled as before in terms of the percentage of staff officers including a given topic in their summaries. Thus, the derived schema was again allowed to be hierarchical in form.

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[1] P.W. Thorndyke, "The Role of Inferences in Discourse Comprehension", Journal of Verbal Learning and Behavior, 1976, 15: 437-446.

In addition to these two procedures designed to extract an underlying schema from the "good" summaries, several other analyses of the data were conducted to facilitate the development of summarization guidelines. Specifically, these analyses addressed the question to what attributes discriminate "good" summaries from "poor" summaries.

2.3.3 RESULTS AND DISCUSSION

Considerable disagreement was observed among the evaluators with respect to which summaries were judged better than others, either in terms of the overall evaluations or in terms of the decomposed ratings of content, accuracy, or organization. Nevertheless, six summaries receiving the highest average overall evaluations (i.e., the "good" summaries) could be isolated for the derivation of a schema that would be useful for portraying the type of intelligence information examined here. For contrast, the six summaries receiving the lowest average overall evaluations (i.e., the "poor" summaries) were also identified. The "good" summaries could be differentiated from the "poor" summaries in terms of content; in general, the former included more information about unit movement, and less information about the composition of second echelon forces.

In terms of a sequential outline for summarization (i.e., the schema), the authors of the "good" summaries tended to first describe the engagement of enemy forces along the border, and then described unit movement both near and behind the border. Following this summary of the <u>dynamic</u> aspects of the enemy situation, the locations of key support units were noted, often in conjunction with a statement regarding the location of

the second echelon. Finally, soon after the inference was made regarding the location of the second echelon, another inference was made regarding the probable point of main thrust by the enemy. Three levels of detail (subordination) could be clearly discriminated from the schema, and these three levels could provide a basis for specific guidelines regarding content and order of presentation for general and more detailed summaries.

Collectively, the evaluators felt that a "good" summary of intelligence information should include hard facts plus an interpretation of what the intelligence information implies, for example, the reporting of enemy unit movement behind the border as possible reinforcements for units already engaged. If a summary contained only a list of facts, categorized or uncategorized, the evaluators made statements like "the summary recipient could have just flipped through the messages himself," or "...too many numbers--not really a summary." Thus, the restatement of intelligence data as indicators of significant features of the enemy situation, such as the point of main thrust or the location of the second echelon, was valued. However, they insisted that the interpretation be wellfounded in the available data as some summaries were rated "poor" because of "illogical" or "unwarranted" interpretation of the data. Also, according to the evaluators, "interpretation should be clearly identified from fact."

With respect to other attributes of the summaries, the majority of the evaluators commented that they preferred summaries that: (1) were "conversational" in style, (2) were organized by zone, sector of the Corps, or area of enemy concentration, (3) included dynamic aspects of

the tactical situation, such as information regarding speed and direction of enemy movement, (4) stated what key information that is not known (i.e., the summary did not leave gaps in the schema because of missing information), and (5) provided estimates of confirmation (reliability) of the intelligence information where appropriate. In general, the "better" summaries were seen as more straightforward, systematic, accurate and informative than the "poorer" summaries.

2.3.4 CONCLUSION

A methodological technique developed within the domain of cognitive psychology was successfully applied to the analysis of written summaries of formatted tactical intelligence messages. Although only 16 staff officers generated the summaries and five experienced military personnel evaluated them, the results provide valuable insight concerning the content and structure of those summaries which are likely to be judged most effective in the communication of information contained in an ESD message file. Such prescriptive norms for "good" summaries can be translated into guidelines, and possibly formats and field procedures, for staff officers to enable them to produce more useful and effective intelligence-message summaries. However, before these summarization guidelines can be implemented in the field, further empirical research is required to assess and validate their effects upon summarization performance, and to evaluate their impact upon tactical decision-making performance. Additional research is also called for to investigate the degree to which these guidelines can be generalized to the summarization of other forms of military messages (e.g., friendly situation data).

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